PROCEDURE FOR THE EXAMINATION OF ARSON EVIDENCE

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These procedures have been reviewed and approved for use by the personnel of the Trace Evidence Section of the State Bureau of Investigation Crime Laboratory. This action does not signify this procedure to be mandated to the extent that it precludes the use of variations of this procedure or different procedures for accomplishing the desired assay. Physical and personnel resources, technological change, and examiner preference (within the bounds of good laboratory technique and quality control) determine what examination procedures are appropriate and / or acceptable for a given set of circumstances as encountered in the Trace Evidence Section.

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This technical procedure will be followed for the examination of arson evidence. For the purpose of arson examination, samples will be divided into three types:

1) Fire debris samples.
2) Liquid samples or samples absorbed onto media from which the liquid may be removed.
3) Single component or very light products (i.e. alcohols, acetones, etc.).

I. Analytical Procedure: Solvent Extraction

A. Suggested Uses: An extraction procedure for arson samples that have accelerant odors.

B. Procedures

1. Transfer a portion of the debris to a clean container, if necessary.
2. Add an adequate amount of appropriate solvent (usually petroleum ether or carbon disulfide).
3. Using a pasteur pipette, rinse the solvent over the debris several times.
4. Separate the solvent from any water that may be present and collect a sample.
5. The solvent extract may be evaporated by light heating or by using a stream of clean nitrogen gas or air to concentrate the sample.
6. Inject a sample of the organic layer into a gas chromatograph and/or mass spectrometer. See instrumental procedures manual or manufacturer's operation manual.

C. Safety Concerns

1. Carbon disulfide may be toxic. Consult Material Safety Data Sheets for information on safe use.
2. Glass pipettes are sharp and can be dangerous.

D. Other Information-consult the Agilent instrument manuals and the Trace Evidence Instrumental Procedures Manual.

II. Analytical Procedure: Heated Headspace Analysis

A. Suggested Uses: An extraction procedure for arson samples that have light solvent odors or alcohol odors.

B. Procedures

1. Puncture a small hole in the can or jar lid and insert a rubber septum. Nylon bags can be sampled through the bag wall.
2. Heat the container and sample to approximately 80^{o}C for approximately 10-15 minutes.
3. Place a new clean 3 mL hypodermic syringe or a reusable 2.5 mL air tight syringe in the oven with the sample.
4. Prepare the gas chromatograph/mass spectrometer by running blanks, loading an appropriate method, and cooling the oven to the initial temperature (See instrumental procedures manual).
5. Remove the sample and syringe from the oven and obtain 0.5 to 1.0 ml. of vapor from the sample.
6. Immediately inject the sample into the GC/MS and begin collecting data.

C. Safety Concern

1. Burns may result from contact with hot items such as containers and syringes.
2. Syringe needles are sharp and can easily puncture skin.

D. Other Information-consult the Agilent instrument manuals and the Trace Evidence Instrument Manual.

III. Analytical Procedure: Diffusive Flammable Liquid Extraction (DFLEX) or Adsorption Elution Extraction (Passive) with Charcoal Strips

A. Suggested Uses: An extraction procedure for arson samples.

B. Procedures

1. Inspect the fire debris sample container for the presence of the red DFLEX device “alert” label. If one is found proceed to step 3.
2. If an alert label is not found, perform one of the following:
   a. DFLEX Device:
      1) Open the DFLEX device pouch.
      2) Remove the cover or cut open the fire debris sample container.

3) Empty the device from the pouch directly into the container. Do not touch the device.
4) Carefully reseal the fire debris container immediately.

b. Charcoal Strip:
1) Open the charcoal strip pouch.
2) Remove the cover or cut open the fire debris sample container.
3) Place the charcoal strip in the sample container being careful not to touch the charcoal strip. Small diameter wire may be used to suspend the charcoal strip in a metal paint can or nylon bag.
4) Carefully reseal the fire debris container immediately.

3. Place the fire debris container with extraction device into an oven for approximately sixteen (16) hours at approximately 60^{o}C.
4. After approximately sixteen (16) hours, remove the fire debris container with extraction device from the oven and allow it to cool.
5. When cool, remove the DFLEX device or charcoal strip from the container. If DFLEX device is used, with a clean cutting device, such as a razor blade, cut through the membrane and remove the charcoal strip.
6. Cut the strip into pieces that will fit into and lay on the bottom of a suitable glass vial.
7. Add approximately 0.5 milliliters of carbon disulfide to the vial to cover the pieces of charcoal strip.
8. Sufficiently agitate the sample to remove any collected volatiles (approximately fifteen (15) minutes in an ultrasonic cleaner).
9. Inject a sample of the carbon disulfide into a gas chromatograph and/or mass spectrometer.

C. Additional Information
1. Refer to the DFELX instruction manual and technical guide for forensic laboratories for additional directions and discussion.
2. See instrumental procedures manual or manufacturer's operation manual for additional instrumental instructions.

IV. Guidelines for arson analysis results

A. ASTM procedures and classifications are used as a guide for flammable/combustible liquid identifications. All results should be based on the chemist's knowledge and experience and the case being examined. Results must be in agreement with the technical reviewer. Examples of classifications include:

1. Light Petroleum Distillates (LPD):
a. At least 4 major peaks in the C4 to C9 range.

b. No major peak above C11.
c. Petroleum distillate pattern comparable to that of known standards.

2. Gasoline:
   a. The m-ethyltoluene/pseudocumene 5-peak group must be present; this group occupies the range between C9 and C10.
   b. Higher peak groupings characteristic of gasoline, such as tetramethylbenzene and 1- and 2-methylnaphthalene, with cutoff between C12 and C13, should also be present.
   c. Hydrocarbon pattern comparable to that of known standards.

3. Medium Petroleum Distillates (MPD):
   a. Pattern starts between C8 and C10 and ends near C13, and contains at least 3 significant peaks between C8 and C13.
   b. Petroleum distillate pattern comparable to that of known standards.

4. Kerosene:
   a. Pattern starts above C8.
   b. At least 5 consecutive n-alkane peaks between C9 and C17 must be present.
   c. Petroleum distillate pattern comparable to that of known standards.

5. Diesel Fuel:
   a. Pattern starts above C8 and should extends to C23.
   b. At least 5 consecutive n-alkane peaks between C9 and C23 must be present.
   c. Petroleum distillate pattern comparable to that of known standards.

6. Medium-Heavy Petroleum Distillate (M-HPD):
   a. Pattern starts between C8 and C10 and ends between C14 and C17.
   b. Petroleum distillate pattern comparable to that of known standards.

7. Heavy Petroleum Distillates (HPD):
   a. Pattern starts above C8.
   b. At least 5 consecutive n-alkane peaks between C9 and C23 must be present.
   c. Also included in the subclass are narrow range (encompassing less than five n-alkanes) distillates starting above C11.
   d. Kerosene and diesel fuel can be included in the HPD classification.
   e. Petroleum distillate pattern comparable to that of known standards.

8. Aromatic:

a. Product comprised almost exclusively of aromatic and/or condensed ring aromatic compounds.
b. Petroleum distillate pattern comparable to that of known standards.

9. Normal Alkane (N-alkane):
   a. Product comprised of only normal alkanes.
   b. Petroleum distillate pattern comparable to that of known standards.

10. Isoparaffinic Products:
   a. Product comprised almost exclusively of branched chain aliphatic compounds.
   b. Petroleum distillate pattern comparable to that of known standards.

11. Naphthenic – Paraffinic Product:
   a. Products are mainly comprised of branched chain and cyclic alkanes.
   b. N-alkanes may be absent or diminished in concentration.
   c. Petroleum distillate pattern comparable to that of known standards.

B. Single compounds, such as alcohols or toluene, may be identified by GC-MS identification of the components.

C. When possible, an unknown sample should be compared to a known standard flammable/combustible liquid in order to confirm the classification. However, no classification system is likely to describe all possible accelerants. Other techniques, such as GC-MS and ion chromatograms, may be used to specifically identify target components of a flammable/combustible liquid.

V. Possible conclusions from the analysis of arson evidence

A. Liquid samples and samples that are extracted by a solvent wash method should be reported by either classifying or identifying the accelerant present. Examples are as follows:
   1. Examination of Item #1 revealed the presence of residual gasoline.
   2. Examination of Items #2 and #5 revealed the presence of residual kerosene.

B. Samples that are extracted by a thermal process (charcoal strip or DFLEX) can show some loss of the lightest and heaviest components. Therefore, results should be reported to reflect this possibility. Occasionally, samples that are extracted by a solvent wash method may report results reflecting the possibility that a complete range of components was not found. Examples are as follows:

1. Examination of Item #1 revealed hydrocarbons consistent with the presence of residual gasoline.
2. Examination of Item #3 revealed the presence of a heavy petroleum distillate. Heavy petroleum distillates include kerosene, diesel fuel and some charcoal starters.

C. Samples that are examined using the Mass Spectrometer can be reported as the specific compound if the library search is of sufficient quality as determined by the examiner and the technical reviewer. An example follows:

> Examination of Item #3 revealed the presence of toluene, xylene, and ethyl benzene.

D. Samples that do not have an accelerant identified result in a "negative" conclusion. Examples of this conclusion include:
1. Examination of Item #1 failed to reveal the presence of an accelerant.
2. Examination of Item #1 failed to reveal the presence of an ignitable liquid.

E. Samples for arson analysis must be packaged in vapor tight containers. If a sample is not packaged in a vapor tight container or is packaged in a container that has been punctured, no analysis can be performed due to the possibility of vapors permeating the container. An example of this conclusion is:

> Item #2 was not examined due to improper packaging. Proper packaging for arson evidence includes nylon bags, glass jars with air tight lids, and lined metal paint cans.

F. Samples can be returned without analysis at the discretion of the analyst and technical reviewer. An example of this would be if Item #2 was the liquid removed from the bottle in Item #1. There would be no reason to analyze both samples as Item #1 would be better served in a possible latent examination. Examples of this conclusion include:

1. No analysis was conducted on Item #1.
2. Item #1 was not needed for analysis.
3. Item #1 was not examined.

VI. Validation references for arson analysis

A. Validation references for diffusive flammable liquid extraction (DFLEX) and passive adsorption elution extraction

1. Various ASTM procedures, including E-1412-00.
2. ATF National Laboratory Center Class, "Laboratory Detection and Identification of Accelerants Found in Arson Debris."
3. Albrayco Laboratories, Inc., DFLEX Instruction Manual and Technical Guide for Forensic Laboratories, Revision II.
4. Demers-Kohls JF, Ouderkirk SL, Buckle JL, Norman WE, Cartwright NS, Dagenais C. "Evaluation of the DFLEX Device for Fire Debris Analysis," Canadian Society of Forensic Sciences Journal, Vol 27(3), 1994.

B. Validation references for solvent extraction

1. Various ASTM procedures, including E-1386-00.
2. ATF National Laboratory Center Class, "Laboratory Detection and Identification of Accelerants Found in Arson Debris."
3. Saferstein, R. Forensic Science Handbook, chapter 6: Arson and Explosive Investigation, pp. 222-239.

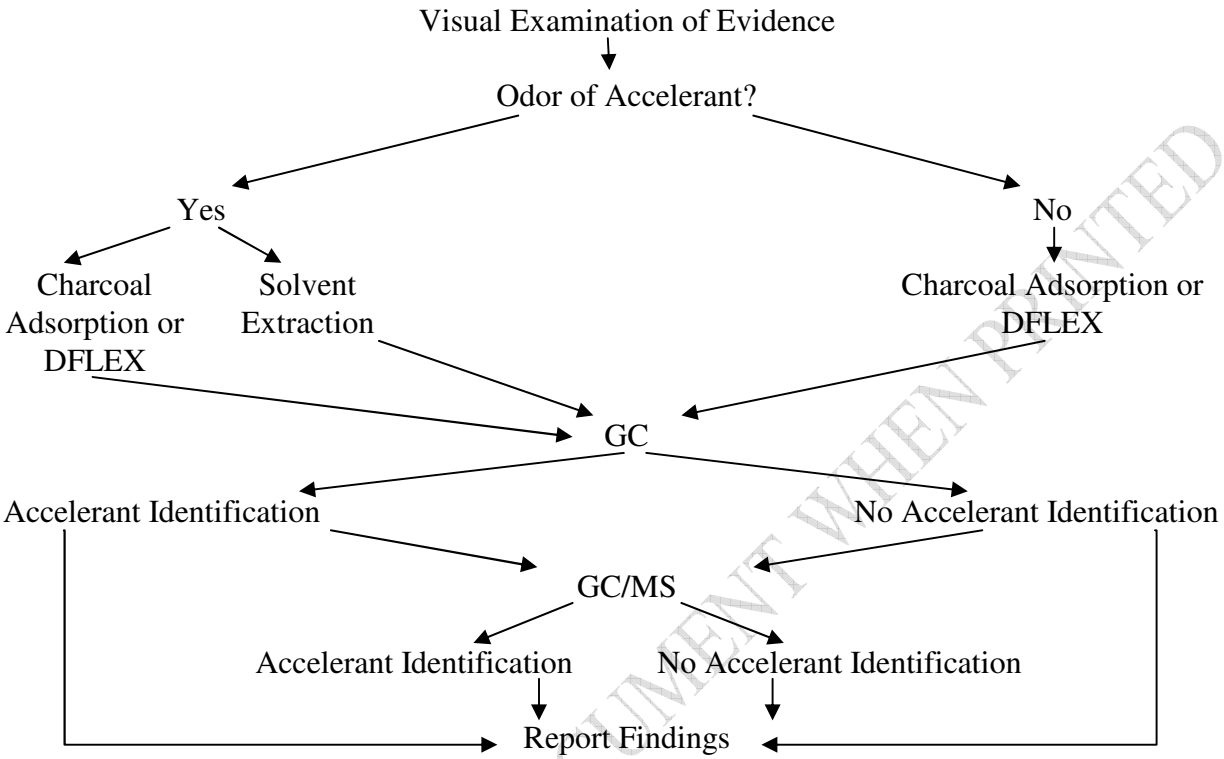
C. Validation references for heated headspace analysis

1. Various ASTM procedures, including E-1388-00.
2. ATF National Laboratory Center Class, "Laboratory Detection and Identification of Accelerants Found in Arson Debris."
3. Saferstein, R. Forensic Science Handbook, chapter 6: Arson and Explosive Investigation, pp. 222-239.

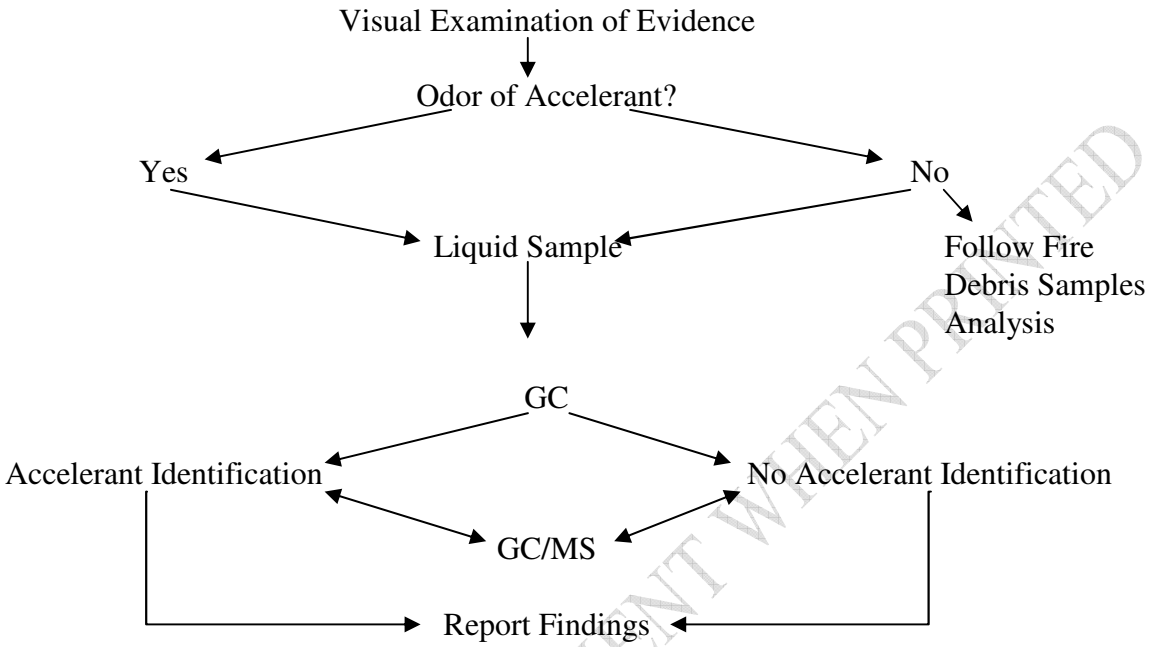
Revision History

Effective Date	Reason
9-28-09	Original Document. Combined all arson procedures into one document. Removed steam distillation procedure. Updated classification guidelines.
3-10-10	Removed dynamic adsorption elution and charcoal tube construction procedures and validation references. Conclusions updated.

General Flow Diagram For Fire Debris Samples



General Flow Diagram For Liquid Sample Analysis



General Flow Diagram for Single Component or Light Products